Exploring WebXPRT 3

WebXPRT 3 uses scenarios that mirror the tasks you do every day to compare the performance of almost any web-enabled device.

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BenchmarkXPRT

BenchmarkXPRT Development Community

Table of contents

Table of contents 2
Introduction 3
Development process 3
WebXPRT 3: The details 3
What's new with WebXPRT 3 4
The HTML 5 capability tests 5
The performance test 5
Test workloads 6
Scoring 7
Test automation 8
After running WebXPRT 9
Submitting results 9
Comparing results to the database 10
Data collection and privacy 10
System information 10
Privacy 11
About the BenchmarkXPRT family of apps 11
What is the BenchmarkXPRT Development Community? 12
The community model 12
Where can I get more information? 12
Conclusion 12

Introduction

WebXPRT 3 is a free benchmark that evaluates the performance of web-connected devices. Like the other BenchmarkXPRT family benchmarks (the XPRTs), it is easy to use, runs relatable workloads, and delivers easy-to-understand results. WebXPRT 3 can complete a performance test in about 15 minutes, but the runtime varies depending on the system.

WebXPRT 3 includes the same core harness and workload structures as WebXPRT 2015, but we updated the workload content and made a few changes and additions that we describe in greater detail below. Because of the updated workloads and changes in our results calculations, WebXPRT 3 results are not comparable to those of WebXPRT 2015.

Below, we explain the development guidelines common to all BenchmarkXPRT tools in general, as well as the specific goals of WebXPRT 3. We discuss the differences between WebXPRT 3 and WebXPRT 2015, the structure of the performance test workloads, the test's scoring methodology, how to automate tests, and how to submit results for publication. We also discuss the WebXPRT data collection mechanisms and our commitment to respecting testers' privacy. Finally, for those interested in more information about the XPRTs, we describe the other benchmark tools in the XPRT family, the role of the BenchmarkXPRT Development Community, and how you can contribute to the XPRTs.

Development process

We build the XPRT apps using a unique community-driven model. Instead of the closed, bottom-up approach used by many benchmarking efforts, we use an open, top-down approach that includes the BenchmarkXPRT Development Community (the community) throughout the design, development, and testing process.

Our approach starts by taking input from the community and examining the most common use cases. We then write a Request for Comment (RFC), proposing use cases to incorporate into the application. Once we have written the RFC, we publish it to the community.

The community's input on the RFC guides the drafting of a design document. The design document then drives the implementation of the community preview, which we release to the community for input. We make changes based on community input from the preview period and finalize the code to create a general release.

We keep results stable between the community previews and the general release so that community members can publish results without waiting for the general release.

WebXPRT 3: The details

WebXPRT is a tool for evaluating the performance and HTML5 capabilities of web-connected devices. WebXPRT 3 is the latest version of WebXPRT, following WebXPRT 2013 and WebXPRT 2015. It uses HTML5, JavaScript, and other web technologies to implement six representative web-user scenarios designed to simulate common web tasks (Photo Enhancement, Organize Album using AI, Stock Option Pricing, Encrypt Notes and OCR Scan, Sales Graphs, and Online Homework). It runs on almost any web-enabled device,[1] from phones to tablets to PCs.

WebXPRT is a hosted service that you can run from webxprt.com or from our mirror site in Singapore.[2] It also supports UIs in Simplified Chinese, German, and English, and provides a syntax for automating the tests.

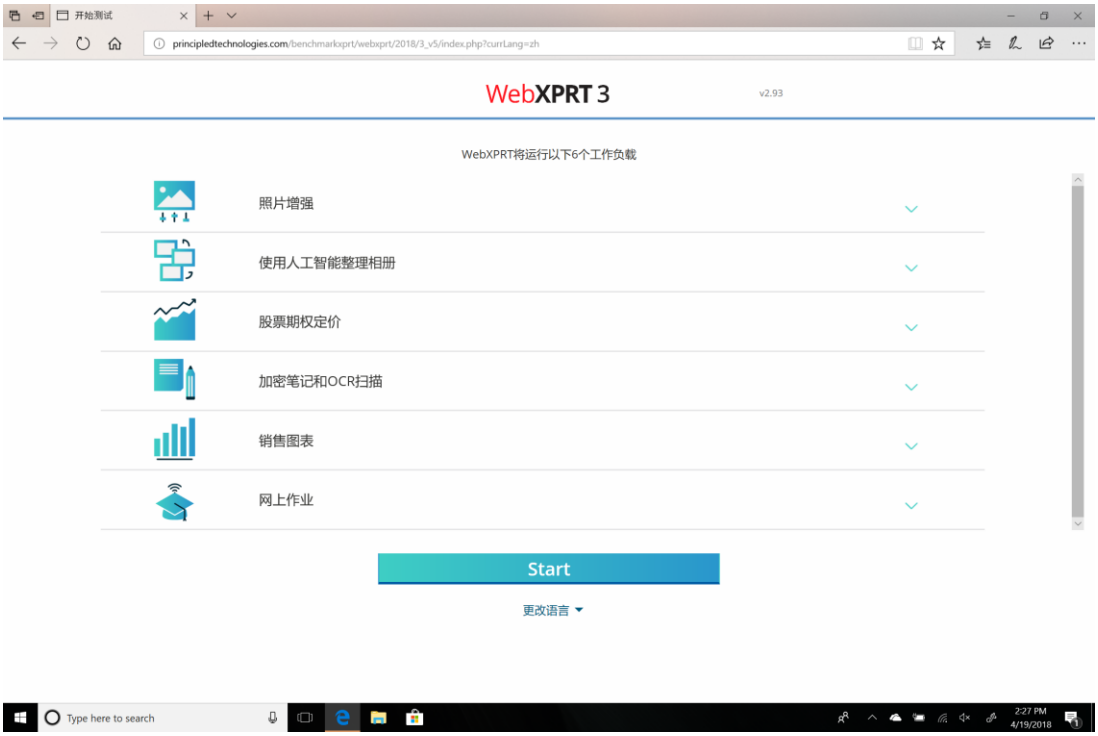

Figure 1: WebXPRT 3's Simplified Chinese UI.

WHAT'S NEW WITH WEBXPRT 3

WebXPRT 3 retains WebXPRT 2015's core harness and workload structures, with the exception of a few changes and additions. The most noticeable change is a new user interface (UI). We redesigned the WebXPRT UI to make it more suitable for mobile environments and to provide testers with a cleaner, more intuitive, and more responsive experience. The UI also provides more on-screen feedback during the test than before, including a test progress bar at the top of the screen and a test completion percentage in the upper right-hand corner. We used the ZURB Foundation[3] framework to build the new mobile-oriented UI.

Other harness changes include the fact that the benchmark now caches harness CSS, JavaScript, and some workload data files to decrease the amount of time needed to complete the test. Additionally, because the PHP team deprecated MySQL functions in PHP 5.5 and above, we transitioned from using MySQL to MySQLi on the back end. We also integrated new performance test workload timers. WebXPRT 3 uses DOMHighResTimeStamp[4] workload timers, accurate to five thousandths of a millisecond (5 microseconds).

We updated each of the six performance test workloads in some way, either by incorporating new media content, updating relevant JavaScript libraries, or augmenting the workload with a new timed task. We discuss the changes we made to each workload in detail in the Test Workloads section below.

Note: Like many applications, WebXPRT uses a number of third-party functions and libraries. The dependencies for each test are included in the test descriptions below. WebXPRT also uses the jQuery library[5] and MooTools utilities.[6]

THE HTML 5 CAPABILITY TESTS

The WebXPRT results screen reports on the HTML5 capabilities of your device by displaying check marks to indicate the capabilities present in your browser and x's to indicate capabilities your browser lacks.[7] We use the Modernizr library to detect HTML5 capabilities.[8] Table 1 lists the HTML5 capabilities that WebXPRT checks.

Capability	Description
Canvas	Draws graphics on a web page
Canvas Text	Draws text on a canvas
Canvas 2D Context	Draws text, lines, boxes, circles, and other 2D figures on a canvas
WebGL	Renders interactive 3D and 2D graphics within any compatible web browser without the use of plug-ins
Audio	Embeds audio in a web page
Video	Embeds a video in a web page
Video Ogg	Serves as a container for the Theora video codec and the Vorbis audio
Video H264	Serves as a container for the H.264 video codec and the AAC audio codec
Video WebM	The WebM format is based on a restricted version of the Matroska container format. It always uses the VP8 or VP9 video CODEC and the Vorbis or Opus audio CODEC.
Geolocation API	Detects the geographical position of a user
Local Storage	Allows web apps to store data locally within the user's browser without cookies.
SVG	Serves as a container for Scalable Vector Graphics (SVG). SVG has several methods for drawing paths, boxes, circles, text, and graphic images.
Web Workers	Allows a JavaScript to run in the background, independently of other scripts.
Uint32ArraySupport	Typed Arrays provide a mechanism for accessing raw binary data.

Table 1: WebXPRT HTML5 capability tests.

THE PERFORMANCE TEST

WebXPRT's performance test measures the speed of web-connected devices as they complete browser-based tasks. These workloads mirror the kinds of things people do on the Internet every day and include the following HTML5- and JavaScript-based workloads: Photo Enhancement, Organize Album using AI, Stock Option Pricing, Encrypt Notes and OCR Scan, Sales Graphs, and Online Homework.

Each workload requires one or more HTML5 capability. The benchmark launches a workload only if the test device supports all the capabilities required for that workload. The result screen indicates any workloads that did not run. The overall result displays only if all workloads run.

WebXPRT runs the six-workload performance suite seven times before calculating the overall score. WebXPRT also reports the individual workload scores. The test takes about 15 minutes to run.

TEST WORKLOADS

We describe the test workloads below. Included in the descriptions are the components that test emphasizes, along with any third-party libraries of functions it uses.

- **Photo Enhancement.** Measures the time to apply three effects (Sharpen, Emboss, and Glow) to two photos each (six photos total). In WebXPRT 3, we increased the dimensions of the photos to 1024 x 768 pixels. Photo Effects exercises HTML5 Canvas, Canvas 2D, and JavaScript performance. It uses the Pixastic JavaScript Image Processing Library.[9]
- **Organize Album using AI.** Measures the time it takes to check for faces and classify images in a set of five photos. In WebXPRT 3, we have added a new task to the Organize Album workload and changed the workload description to "Detects faces and classifies images using the ConvNetJS neural network library."
    - The workload includes two tasks, each of which organize a different album:
        - Task 1: The first task uses the same workload as WebXPRT 2015, with updated images. This workload organizes five images using ccv.js[10] and face.js, which Dr. Liu Liu ported to JavaScript.
        - Task 2: We added image classification using AI to the second task through convnet.js. The workload classifies (labels) five images in an album using ConvNetJS.[11] We obtained the model we use from the sample "Classify CIFAR-10 with Convolutional Neural Network."[12] The model is trained on the Cifar10 dataset[13] using ConvNetJS.

    The dimensions of the photos are 720 x 480, 718 x 480, and 640 x 480 pixels. Organize Album using AI exercises HTML5 Canvas, Canvas 2D, and JavaScript performance. The workload reports the total time taken to organize the two albums.
- **Stock Option Pricing.** Calculates and displays graphic views of a stock portfolio. In WebXPRT 3, we have changed the workload description to "Calculates and displays graphics views of a stock portfolio using Canvas, SVG, and dygraph.js." We updated the data file (sp500_20131201_20140601.json) and changed the range of years to end in 2017 so the UI is up to date. Stock Option Pricing exercises HTML5 Canvas, SVG, and JavaScript performance. It uses the dygraphs JavaScript charting library.[14] We updated the dygraph.js library to version 2.0.[15] The workload reports the total time taken to create and display three graphs.
- **Encrypt Notes and OCR Scan.** In WebXPRT 3, we have added a task to the Offline Notes workload and changed the workload description to "Encrypts notes in local storage and scans a receipt using OCR." The workload now reports the total time taken to sync notes, extract text from a scanned receipt, and add the scanned text to a spending report. The sync notes portion of the workload measures HTML5 Local Storage, JavaScript, AES encryption, and asm.js performance. It uses the localStorageDB.js database layer for localStorage and sessionStorage,[16] the Emscripten LLVM-to-JavaScript Compiler,[17] and aes.c for AES encryption. The scan receipt portion of the workload uses tesseract.js-core[18] and eng.traineddata[19] to perform optical character recognition (OCR).
- **Sales Graphs.** Provides a web-based application displaying multiple views of sales data. Sales Graphs exercises HTML5 Canvas and SVG performance. In WebXPRT 3, we changed the

workload description to “Calculates and displays multiple views of sales data using InfoVis and d3.js.” The workload uses the d3.js JavaScript library for manipulating documents based on data.[20] We updated the d3.js library to version 4.[21] We also updated the data file (salesData.json), changed the range of years to end in 2017 so the UI is up to date, and changed the default settings for the pie graph to not use animation while creating the graph. The workload reports the total time it takes to calculate and display seven views of sales data.

- **Online Homework.** Measures the time it takes to complete eight DNA sequencing tasks and spell check an essay. In WebXPRT 3, we have changed the name of the “Explore DNA Sequencing” workload to “Online Homework,” added a spell-check task, and changed the workload description to “Performs science and English homework using Web Workers and Typo.js spell check.” The DNA Sequence Analysis portion of the Online Homework workload exercises HTML5 Web Worker and JavaScript (String, regexp and array) performance. It uses the findPotentialStartsAndStops and findORFsinSeq[22] functions, and the Sequence Manipulation Suite.[23] Both tasks use regex, arrays, strings, and Web Workers. We updated the DNA sequencing function that finds Open Reading Frames to use regex. This algorithm is faster than the previous version, and fixes an issue caused by a loop overrun.

  The new spell-check workload is based on typo.js.[24] The workload uses Hunspell-style dictionaries. We use text from “The Yosemite” by John Muir.[25] The workload reports the total time to complete the DNA sequencing tasks and spell-check the essay.

Scoring

The primary performance result is the overall score that the benchmark calculates. For that score, higher results are better. WebXPRT also reports individual results for the six performance workloads. These results report the average time (in milliseconds) that it took to run the workload. Because those results are times, lower scores indicate faster performance and are better. As with the other BenchmarkXPRT benchmarks, the overall score is relative to a calibration device. For WebXPRT 3, the calibration device is an Apple iPad Pro 10.5" running iOS 11.1.

WebXPRT includes a confidence interval, a measure of the uncertainty of the score or result, with each individual score and the overall result. An example is 155 ±3. The percentage expresses a confidence interval at a 95% confidence level, a common level for this type calculation.[26] This means that if you were to repeat the test on the same system using the same test procedures, 95 percent of the time you could expect the results to fall within the confidence interval WebXPRT reports. For example, the results would mostly fall within the range of 152 to 158 for the 155 ±3 example.

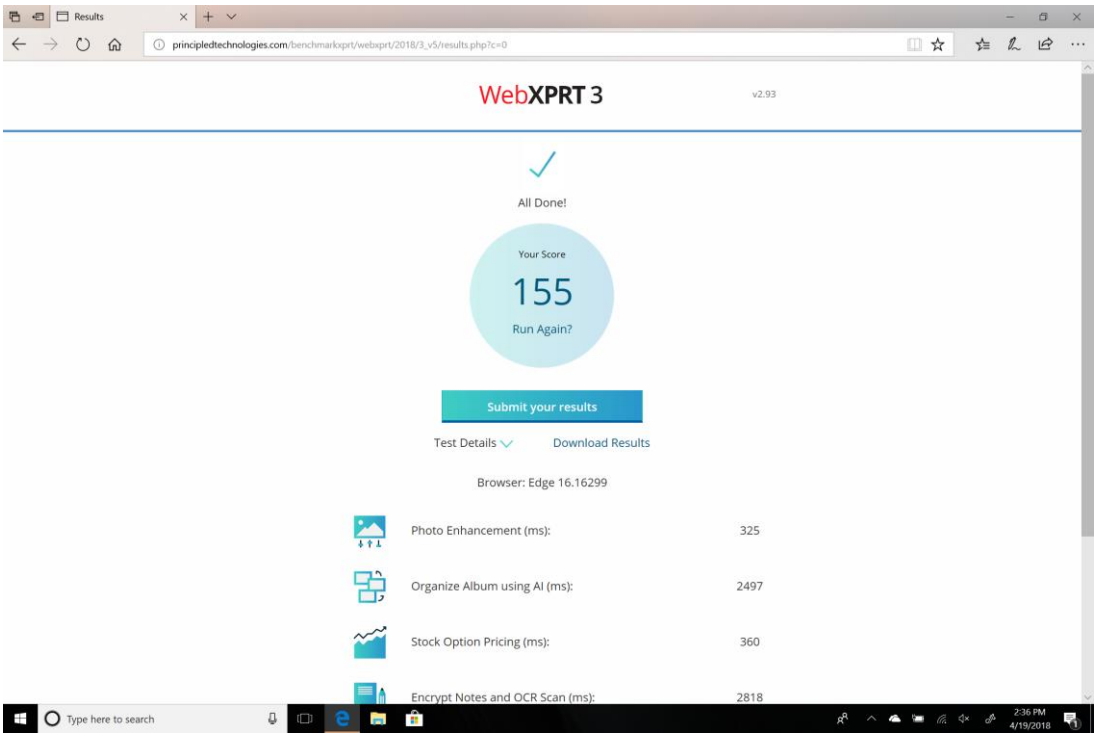

Figure 2: The WebXPRT 3 results page.

In the white paper "WebXPRT 3 results calculation and confidence interval,"[27] we explained in detail how WebXPRT 3 calculates results. We have also provided a spreadsheet showing the exact calculations for a WebXPRT 3 result.[28]

To avoid confusion, we rescale the results every time we release a new version of a benchmark. By making the results obviously different, we hope to reduce the likelihood that users will inadvertently mix results from two different versions. If you are familiar with WebXPRT 2015, please be aware that for any test platform, WebXPRT 3 scores will be quite a bit lower than WebXPRT 2015 score.

Test automation

WebXPRT 3 lets you run scripts in an automated fashion. You can control the execution of WebXPRT 3 by appending parameters and values to the WebXPRT URL. Three parameters are available, testtype, tests, and result.

testtype

WebXPRT provides two test types:

- Core tests: 1
- Experimental tests: 2

As we write this white paper, WebXPRT 3 contains no experimental tests and we have disabled this option. However, we included it for future use.

tests

This parameter lets you specify which tests to run. To run an individual test, use its code:

- Photo Enhancement: 1
- Organize Album using AI: 2

- Stock Option Pricing: 4
- Encrypt Notes and OCR Scan: 8
- Sales Graphs: 16
- Online Homework: 32

To specify multiple tests, sum the codes. For example, to run stocks (4) and notes (8), use the sum of 12. To run all core tests, use 63, which is the sum of all the individual test codes (1 + 2 + 4 + 8 + 16 + 32 = 63).

result

You can select from four results formats:

- Display the result as an HTML table: 1
- Display the result as XML: 2
- Display the result as CSV: 3
- Download the result as CSV: 4

To use the automation feature, start with the URL http://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/3_v5, append a question mark (?), and add the parameters and values. You must specify values for all three parameters. For example, to run all the core tests and download the results, you would use the following URL: http://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/3_v5/auto.php?testtype=1&tests=63&result=4

After running WebXPRT

SUBMITTING RESULTS

WebXPRT 3 allows you to submit results to Principled Technologies for us to display on the results page. On the Results screen, click the Submit button, and complete the fields for contact email, device name, model number, operating system, and browser name and version. You also have the option to add additional information. PT will store your email address securely and confidentially and will not use it for any purpose other than contacting you regarding the result submission. Once you have completed the necessary fields, click Submit.

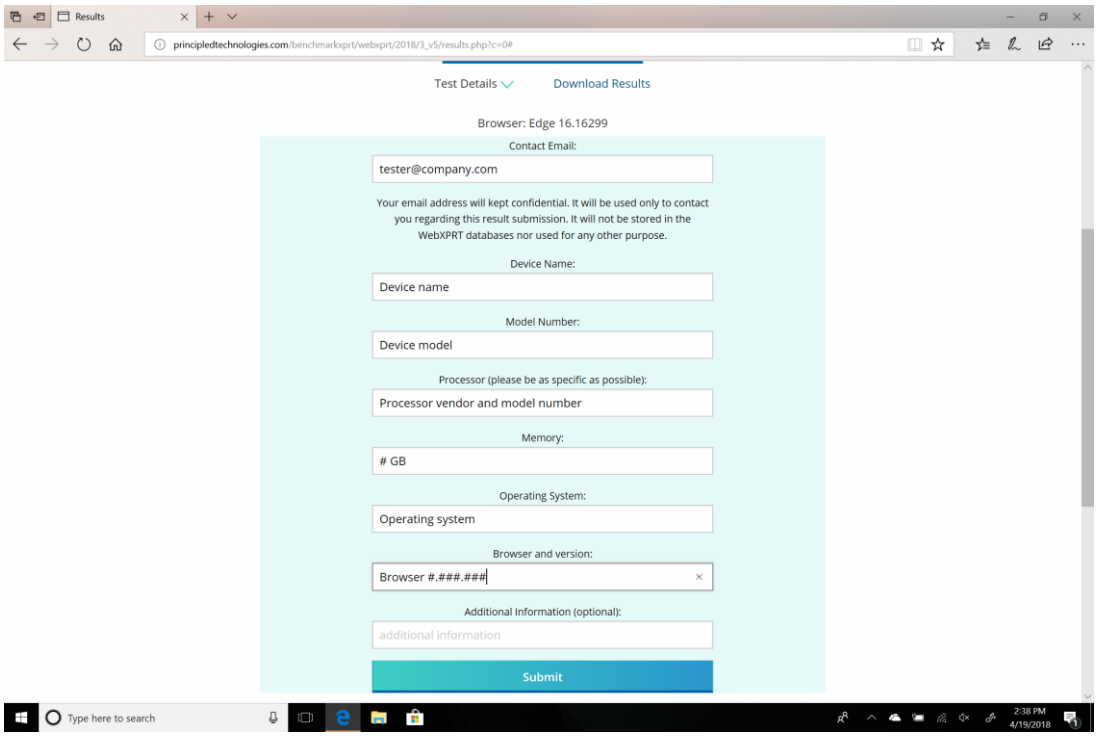

Figure 3: Submitting results after a run.

COMPARING RESULTS TO THE DATABASE

The WebXPRT 3 results page[29] presents results for tests that PT ran, results published by the technology media, and results users have submitted. To find detailed information on any set of scores, click the link in the Source column.

Data collection and privacy

SYSTEM INFORMATION

WebXPRT 3 collects descriptive information about the test platform. We have published a disclosure document online that lists the data that WebXPRT collects for each test system.[30]

Because WebXPRT runs on such a wide range of devices and browsers, obtaining information on the test platforms is difficult. The system information for WebXPRT consists of the user agent string the browser reports, exactly as WebXPRT 3 receives it. The information the user agent string reports may be incorrect, but the benchmark does not attempt to verify its accuracy. We made this decision based on the assumption that the browser had a reason for setting it the way it is.

In the process of developing WebXPRT, we investigated using the JavaScript Navigator object as a way to improve the system information that WebXPRT reports. While the information it delivers also can be inaccurate, we report some of it along with a disclaimer. Below, we show the system information that WebXPRT reports from an Apple MacBook Pro running macOS High Sierra 10.13.5.

User agent string provided the following information:

- Mozilla/5.0 (Macintosh; Intel Mac OS X 10_13_5) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/67.0.3396.99 Safari/537.36

JavaScript Navigator provided the following browser information.

- Browser Version: Platform:mac,Browser:chrome 67
- Language: en

PRIVACY

Upon launch, WebXPRT displays the benchmark's data collection notice and a link to the BenchmarkXPRT Development Community's privacy policy.[31] WebXPRT does not gather personally identifying information or display individual results publicly without the tester's permission.

When you run WebXPRT, it collects the test results and some data about the browser on the device that produced those results and stores this information in a database. When you run the benchmark, you permit Principled Technologies to store this information and use the data WebXPRT collects for the purposes of improving the benchmark. In addition, you permit Principled Technologies to quote aggregate results and result ranges (such as high, low, and average scores and the number of results). PT will not make individual WebXPRT results public without your permission. In addition, WebXPRT does not report, and therefore PT cannot make public, identifying personal or corporate data, or any other potentially confidential information.

As we noted earlier, you must provide your email address when submitting results. PT will store your email address securely and confidentially and will not use it for any purpose other than contacting you regarding the result submission.

About the BenchmarkXPRT family of apps

The BenchmarkXPRT tools are a set of apps that help you test how well devices do the kinds of things you do every day. In addition to WebXPRT 3, the BenchmarkXPRT suite currently comprises the following tools:

- BatteryXPRT 2014 for Android, an app to measure the battery life and performance of Android-based phones and tablets
- CrXPRT 2015, an app to test the responsiveness and battery life of Chromebooks
- MobileXPRT 2015, an app to test the responsiveness of Android devices
- TouchXPRT 2016, a Universal Windows Platform app to test the responsiveness of Windows 10 devices
- HDXPRT 2014, a program that uses commercial applications to test the capabilities and responsiveness of PCs running Windows 10

We designed the apps to test a wide range of devices on a level playing field. When you look at results from XPRTs, you get unbiased, fair product comparison information.

What is the BenchmarkXPRT Development Community?

THE COMMUNITY MODEL

The BenchmarkXPRT Development Community is a forum where registered members can contribute to the process of creating and improving the BenchmarkXPRT family, including WebXPRT. If you are not currently a community member, we encourage you to join. The community is open to everyone, from software developers to interested consumers, and there are many different ways to participate. Not only will you get early releases of future versions of WebXPRT, but you will also be able to download the source code (available to members only) and influence the future of the app. Register now, or for more information, see the BenchmarkXPRT FAQ.

Members of the BenchmarkXPRT Development Community are involved in every step of the process. They give input on the design of upcoming versions, contribute source code, and help test the resulting implementation. Community members have access to the source code and access to early releases in the form of community previews.

The community helps us avoid the ivory tower syndrome. Diversity of input during the design process makes the tests more representative of real-world activity. Giving community members access to the source code both improves the implementation of the design and increases testers' confidence in the code.

The community model differs from the open source model primarily by controlling derivative works. It is important that the BenchmarkXPRT benchmarks return consistent results. If the testing community calls different derivative works by the same name, the test results would not be comparable. That would limit, if not destroy, the tools' effectiveness.

WHERE CAN I GET MORE INFORMATION?

Visit us at WebXPRT.com or follow us on Twitter and Facebook. We announce breaking news on the BenchmarkXPRT blog (available to everyone) and the BenchmarkXPRT forums (available to members only). If you cannot find the answer to your question, or if you need help with WebXPRT, send an email to our team at BenchmarkXPRTsupport@principledtechnologies.com.

Conclusion

We hope this paper has answered any questions you may have about WebXPRT 3. If you have any other questions, or if you have suggestions on ways to improve WebXPRT, please post them on the community forum or e-mail us at BenchmarkXPRTsupport@principledtechnologies.com. For more information, visit us at BenchmarkXPRT.com and WebXPRT.com.

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[1] WebXPRT runs on all major browsers and operating systems. The test may not run on legacy browsers or operating systems.
[2] http://webxprteast.principledtechnologies.com/webxprt/2018/3_v5/?currLang=zh.
[3] "Foundation, the most responsive front-end framework in the world," accessed July 16, 2018, https://foundation.zurb.com/.
[4] "performance,now()," accessed July 16, 2018, https://developer.mozilla.org/en-US/docs/Web/API/Performance/now.
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[16] "knadh/localStorageDB," accessed July 16, 2018, https://github.com/knadh/localStorageDB.
[17] "kripken/emiscripten," accessed July 16, 2018, https://github.com/kripken/emscripten.
[18] "naptha/tesseract.js-core," accessed July 16, 2018, https://github.com/naptha/tesseract.js-core.
[19] "tesseract-ocr/tessdata," accessed July 16, 2018, https://github.com/tesseract-ocr/tessdata.
[20] "Data-Driven Documents," accessed July 16, 2018, https://d3js.org/.
[21] Ibid.
[22] "Bioinformatics 0.1 documentation," accessed July 16, 2018, http://a-little-book-of-r-for-bioinformatics.readthedocs.org/en/latest/ (These functions were ported from R code to JavaScript).
[23] "The Sequence Manipulation Suite," accessed July 16, 2018, http://imed.med.ucm.es/Tools/SMS/d_load.html.
[24] "cfinke/Typo.js," accessed July 16, 2018, https://github.com/cfinke/Typo.js/.
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[26] "Confidence interval," accessed July 16, 2018, http://en.wikipedia.org/wiki/Confidence_interval.
[27] http://www.principledtechnologies.com/benchmarkxprt/whitepapers/webxprt/WebXPRT3_results_calculation_paper.pdf.
[28] You will find the spreadsheet at https://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/WebXPRT3_results_calculation_sheet.xlsx. The results that the spreadsheet uses are published at http://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/details.php?resultid=32.
[29] http://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/results
[30] http://www.principledtechnologies.com/benchmarkxprt/webxprt/2018/WebXPRT-2018-data-collection.pdf
[31] http://www.principledtechnologies.com/benchmarkxprt/privacy

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